



**Science Mission
Directorate**

NASA Program Status

**Ramesh Kakar
Weather Focus Area Leader
TRMM, Aqua and GPM Program Scientist
June 21, 2010**



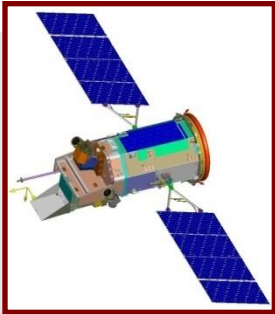
A wide banner image featuring a collage of space-related scenes: a view of Earth from space on the left, a ringed planet in the center, and a spiral galaxy on the right. The text "NASA Operating Missions" is centered in white.

NASA Operating Missions

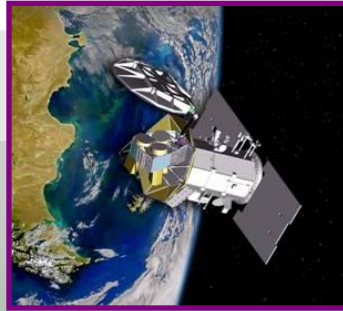
Mission	Program Sci	Launch	Phase	Extension to	Dec	Jan	Feb	Comments
TRMM	R. Kakar	11/27/1997	Extended	9/30/2011				Participates in Hurricane Related Research
QuikSCAT	E. Lindstrom	6/19/1999	Extended	9/30/2011				Participated in Hurricane Related Research
Terra	G. Gutman	12/18/1999	Extended	9/30/2011				Participates in Hurricane Related Research
ACRIMSat	R. Kakar	12/20/1999	Extended	9/30/2011				
NMP EO-1	G. Gutman	11/21/2000	Extended	9/30/2011				
Jason	E. Lindstrom	12/7/2001	Extended	9/30/2011				Participates in Hurricane Related Research
GRACE	J. Labrecque	3/17/2002	Extended	9/30/2011				
Aqua	R. Kakar	5/3/2002	Extended	9/30/2011				Participates in Hurricane Related Research
ICESat	T. Wagner	1/12/2003	Extended	9/30/2010				
SORCE	R. Kakar	1/25/2003	Extended	9/30/2011				
Aura	E. Hilsenrath	7/15/2004	Prime thru 9/10	9/30/2011				
Cloudsat	D. Considine	4/28/2006	Extended	9/30/2011				Participates in Hurricane Related Research
CALIPSO	D. Considine	4/28/2006	Extended	9/30/2011				Participates in Hurricane Related Research
OSTM	E. Lindstrom	6/20/2008	Prime thru 6/11	Ends 6/30/11				Participates in Hurricane Related Research
			On plan, adequate margin, no significant issues.					
			Problems, working to resolve within planned margin					
			Problems, not enough margin to recover					



ESD Missions in Development & Formulation



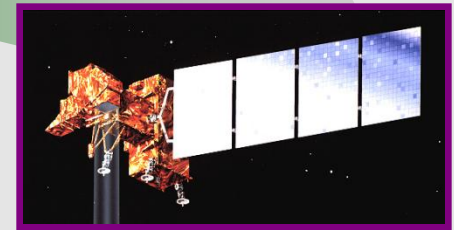
GLORY
Late 2010



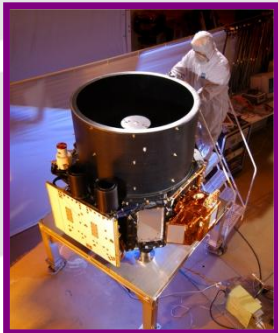
AQUARIUS
Late 2010



NPP
Sep 2011



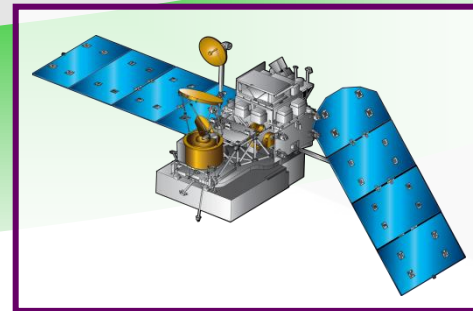
LDCM
Dec 2012



ICESat-2
Late 2015



SMAP
Nov 2014

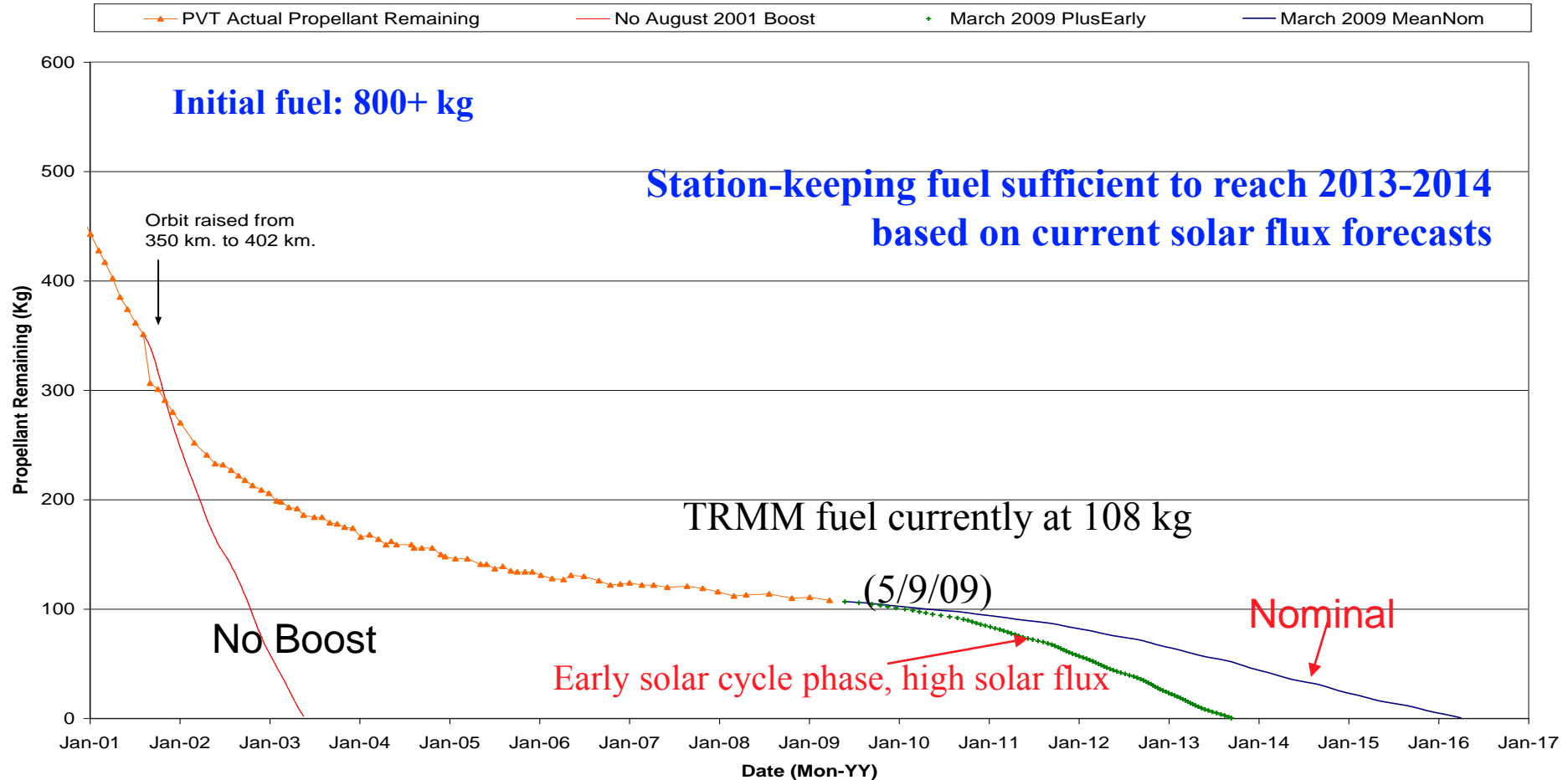


GPM
Jul 2013
Nov 2014

TRMM Status

- *TRMM completed 12 years of on-orbit operations on November 27, 2009 (with 8 years at 402 km and 3+ years at 350 km)*
- *TRMM began as an experimental mission, but has become a standard reference for a global set of satellites used to study precipitation characteristics and variability, and is being used in near real-time applications*
- *Recently completed the Senior Review process for the third time*
- *Instruments (LIS, PR, TMI, VIRS) and spacecraft remain in excellent operating shape with some minor degradations*
- *Based on current fuel consumption expectations, TRMM data could be available into 2013-2014, providing the potential for overlap with GPM*

TRMM Lifetime – March 2009 Schatten Update



GPM Reference Concept

An international satellite mission to unify and advance global precipitation measurements from dedicated and operational satellites

Low-Inclination Observatory (40°)

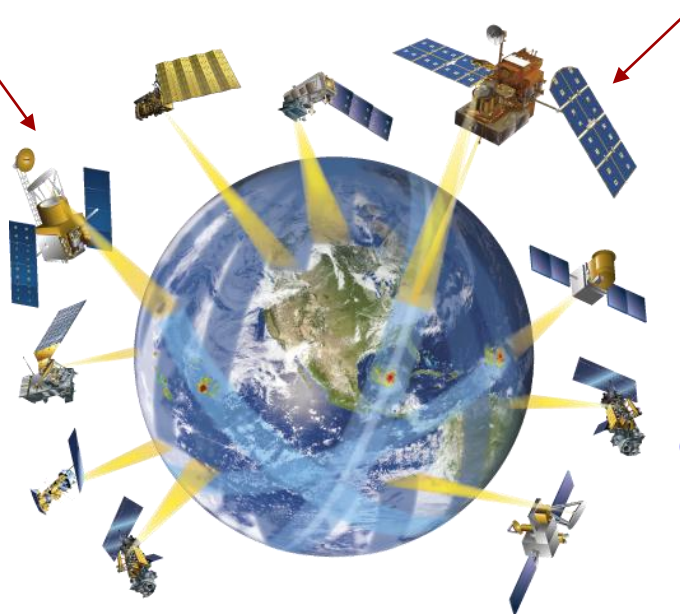
GMI (10-183 GHz)
(NASA & Partner LRD 2014)

- Enhanced temporal sampling for near-realtime monitoring of hurricanes and midlatitude storms
- Improved estimation of rainfall accumulation

GPM CORE Observatory (65°)

DPR (Ku-Ka band)
GMI (10-183 GHz)
(NASA-JAXA, LRD 2013)

- Precipitation physics observatory
- Reference standard for inter-calibration of constellation precipitation measurements



Partner Satellites:

GCOM-W1, DMSP, Megha-Tropiques, plus MetOp, NOAA-N', NPP, NPOESS (over land)

NASA & JAXA precipitation data processing systems

Next-generation global precipitation products with improved accuracy and consistency within a unified framework

International science cooperation

Radiometer Intercalibration, algorithm development, and ground validation

- **Technical**

- Implementation Phase (Phase C) well underway with July 2013 LRD
 - Key Decision Point-C (KDP-C) process completed in December
 - Mission CDR held in December
 - Ground system CDR scheduled for next month
- GPM Microwave Imager
 - GMI#1 subsystems in fabrication and test
 - GMI #1 integration scheduled for this fall with delivery in summer 2011
 - GMI#2 procurement initiated in October with delivery in late 2012
 - Long lead components/assemblies being fabricated at subcontractors
- JAXA DPR (KuPR & KaPR) in assembly and test
 - Pre-Environmental Review (PER) scheduled for this fall
- Core Spacecraft
 - ETU testing nearing completion
 - Subsystem Manufacturing Readiness Reviews (MRRs) being completed
 - Spacecraft I&T to begin late this year
- Precipitation Processing System (PPS)
 - Routinely producing 1C products for TMI, SSMI, AMSRE, SSMIS (including F16), and WindSat
 - Supporting X-calibration Working Group (in coordination with WMO CGMS/GSICS)
 - Producing V6 of TRMM near real time merged products that include AMSU data from NOAA-19 and MHS data from MetOp-A



- **Budget**

- \$32M of ARRA (aka “stimulus”) funding in FY2009
- NASA’s FY2010 budget funds GPM at \$156M
- NASA’s proposed FY2011 budget funds GPM at \$129M

- **International Partnerships**

- NASA-JAXA Implementation MOU signed July 2009
- Developing formal agreement with CNES/ISRO on Megha-Tropiques participation in GPM
- NASA-AEB/INPE joint study agreement under review
- Developing formal agreement with EUMETSAT

- **Domestic Partnerships**

- Developing inter-agency agreement with NOAA
- NPOESS restructuring
 - OSTP announced NPOESS restructuring February 1
 - ATMS remains onboard Joint Polar Satellite System (JPSS) NOAA/NASA “afternoon orbit” spacecraft
 - MIS status unclear on DOD “morning orbit” Defense Weather Satellite System (DWSS) spacecraft
 - Expect further clarity in next few months



- **LIO**

- *KDP-C baseline (and proposed FY2011) budget fully funds*
 - GMI#2
 - GMI#2 integration on partner spacecraft
 - TDRSS comm subsystem for global near real time data access
 - Science operations and data analysis
- *Partnership development*
 - INPE has expressed interest in partnering on the LIO
 - Anticipate substantive progress in 4QCY2010





NASA Research Announcement

Science Mission Directorate
NASA Research Announcement
Precipitation Science Team
Solicitation: NNH09ZDA001N

Date Released February 13, 2009

NOIs Due June 15, 2009

Proposals Due August 17, 2009

Funds likely to be available: ~ \$8 M/year for 3 years

Number of Awards: 45-55 out of ~150 proposals

This solicitation was for the selection of the 7th Precipitation Science Team

No-cost research proposals can be accepted from international investigators to complement existing science team activities



Research Categories

- ⑩ 1.0 Algorithm Development and Validation
- ⑩ 2.0 Utilization of Satellite/GV Products for Process Studies and Model Development
- ⑩ 3.0 Methodology Development for Improved Applications of Satellite Products
- ⑩ Result: 58 proposals selected for funding out of 126 received



International GV Science Collaboration

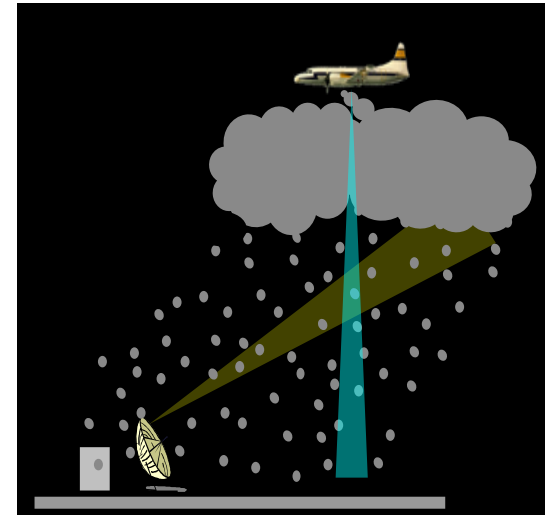
- *Direct statistical validation (surface)*
- *Precipitation physics validation (vertical column)*
- *Integrated science validation (4-dimensional)*

Active Projects

- Argentina (U. Buenos Aires)
- Australia (BOM)
- Brazil (INPE)
- Canada (EC)
- Ethiopia (AAU)
- Finland (FMI)
- France (CNRS)
- India (ISRO)
- Germany (U. Bonn)
- Israel (Hebrew U. Jerusalem)
- Italy (CNR-ISAC)
- Italy (Sapienza U. Rome)
- South Korea (KMA)
- Spain (UCLM)
- United Kingdom (U. Birmingham)

Proposals in Development

- Cyprus (CMS)
- Germany (MPI)
- Spain (Barcelona)
- Taiwan



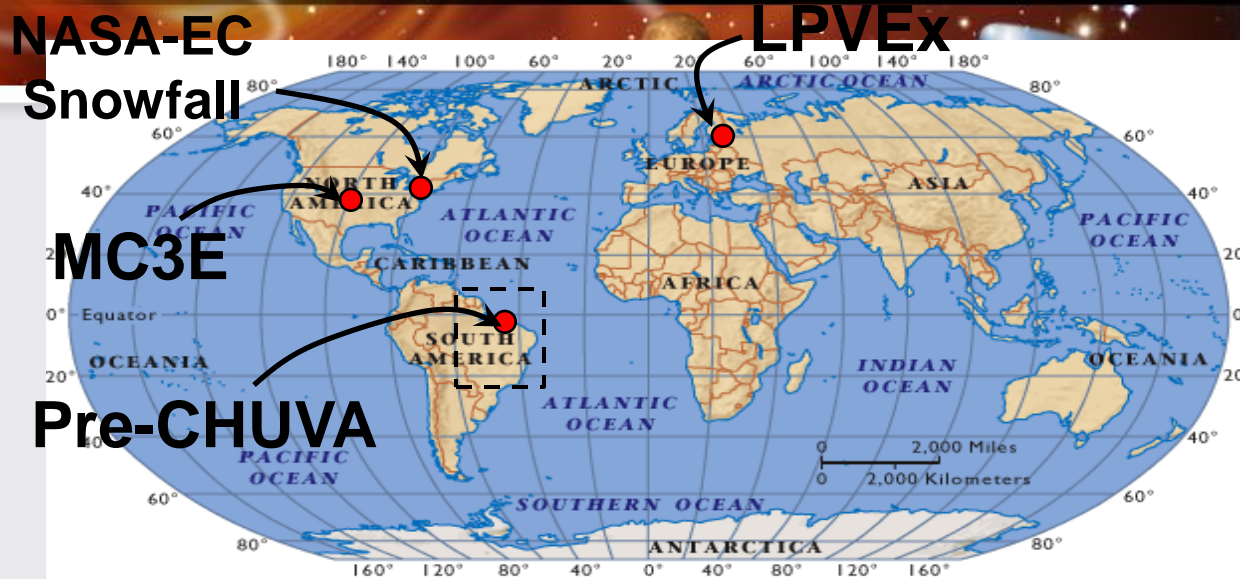
Through No-Cost Proposals to NASA PMM
Science Program

Some Recent and Upcoming Meetings of Interest

- ⑩ Annual NASA PMM Science Team Meeting, Salt Lake City, Utah; October 26-29, 2009
- ⑩ CEOS Precipitation Constellation Workshop, Salt Lake City, Utah; October 29, 2009
JPST + JAXA PMM Science Team, Tokyo, Japan; April 2010
- ⑩ 4th International GPM GV Workshop, Helsinki, Finland; June 2010
- ⑩ Annual NASA PMM Science Team Meeting, Seattle, Washington; Early November, 2010
- ⑩ 9th GPM International Planning Workshop, TBD; 2011



Physical Validation: Field Campaigns (2010-2012)



- Pre-CHUVA/CHUVA: GPM-Brazil/NASA GPM tropical rain (warm, ice) field campaign, March 2010
- LPVEX (Light Precipitation Validation Experiment): CloudSat-GPM cold latitude light rain in shallow melting layer situations. Fall 2010
- MC3E (Mid-Latitude Continental Clouds Experiment): GPM-DOE mid-latitude continental rainfall; spring/summer 2011
- NASA-EC Snowfall Campaign: GPM-Environment Canada snowfall research; early 2012





LPVEx Field Campaign (Sept. 15 – Oct. 24, 2010)

Target: Light rain in cold low altitude melting layer environment

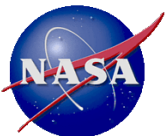
GV Science:

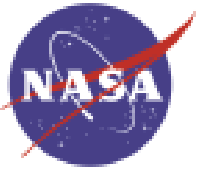
- Quantify column DSD/precip variability over inland, coastal, sea regimes
- Melting layer physics coupled to water below and ice above
- Reconstructed Ka-Ku band (DPR) data for DFR algorithm testing
- Observationally-validated model databases for radiometer algorithms

Approach:

- Heavily instrument surface sites + 1 Ship under radar/aircraft/satellite coverage at Järvenpää (*inland*), Harmaja (*Island*), Emasalo (*coast*), and R/V Aranda (*sea*)
- 3 Dual-pol radars, 6-8 disdrometers/4-MRRs/ADMIRARI radiometer/3 POSS U. Wyoming King Air Airborne microphysics + W-band radar

Sampling in Helsinki-Testbed
Gulf of Finland

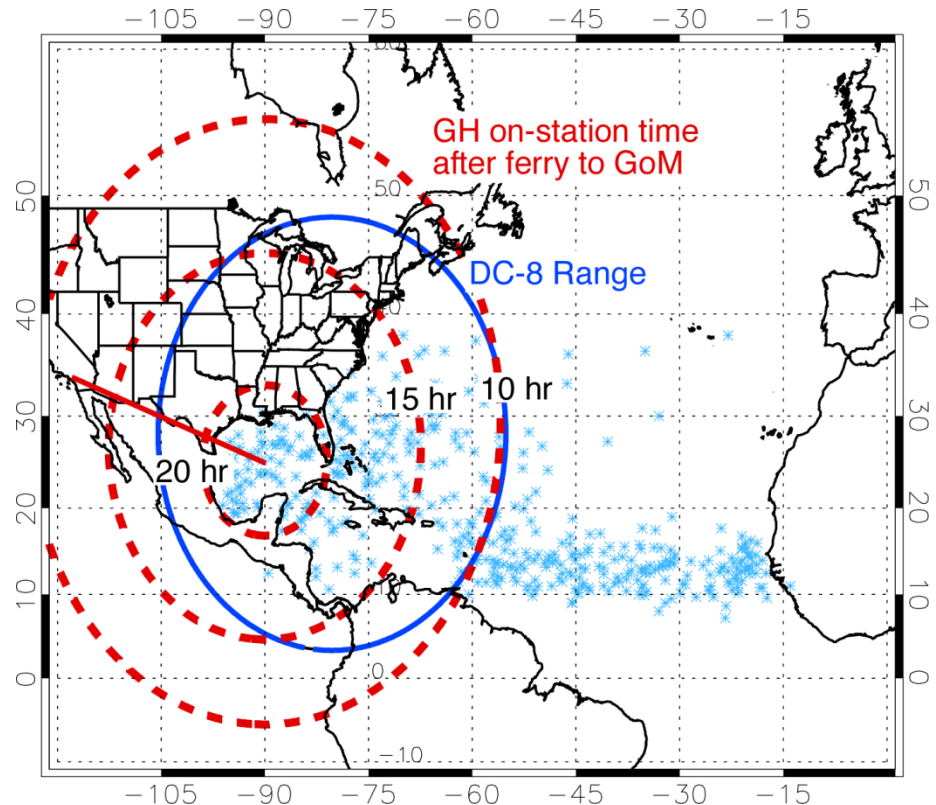




GRIP: (Hurricane) Genesis and Rapid Intensification Processes Field Experiment

- Global Hawk (UAV) (240 hours)
 - **Radar (Heymsfield/GSFC), Microwave Radiometers (Lambrigtsen/JPL), Dropsondes (NOAA), Electric Field (Blakeslee/MSFC)**
 - Geosynchronous Orbit Simulation
- DC-8 four engine jet (120 hours)
 - **Dual frequency precipitation radar (Durden/JPL)**
 - Dropsondes (Halverson/UMBC), Variety of microphysics probes (Heymsfield/NCAR)
 - **Lidars for 3-D Winds (Kavaya/LaRC) and for high vertical resolution measurements of aerosols and water vapor (Ismail/LaRC)**
 - In-situ measurements of temperature, moisture and aerosols (Bui/ARC)
- Six to Eight week deployment centered on September 1, 2010

RED= IIP, GREEN= IIP+AITT



Blue line: DC-8 range for 12-h flight, 6 h on station

Red lines: GH range for 30-h flight with 10, 15 and 20 h on station

Light blue X: Genesis locations for 1940-2006

Summary

- TRMM going strong and GPM core satellite is on track for launch in July 2013
- New science team selected in Feb. 2010:
 - No interruption in key algorithm and GV activities.
 - Algorithm Teams on track to deliver codes for PPS Build #1 in Nov. 2010.
 - Joint field campaign with Brazil target warm rain processes completed in March 2010.
 - Joint field campaign with CloudSat and Finland targeting light precipitation on track for Sept. 2010 experiment in Helsinki
 - FMI hosting the 4th International Workshop for GPM GV on June 21-23 in Helsinki, FI.
 - PPS is already operational and routinely producing TRMM data including multisatellite constellation-based products. PPS and key algorithm developers have long experience working together since TRMM.
- Tremendous international support for radiometer intercalibration, ground validation, and data applications
 - 14 active international science projects with more underway